AVO INTERNATIONAL

INSTRUCTION MANUAL

For

CURRENT TRANSFORMER EXCITATION TEST SET

MODEL CTER-91

It is essential that this instruction book be read thoroughly before putting the equipment in service.

4271 BRONZE WAY DALLAS, TEXAS 75237-1088 USA PHONE: (214) 333-3201 FAX: (214) 339-7505

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SAFETY PRECAUTIONS

Please read this manual carefully and completely prior to using the unit. Read and understand all safety, caution and operation instructions before attempting to use this unit. Should a situation arise that is not covered in the general or specific safety precautions, contact your local Multi-Amp representative or Multi-Amp Corporation, Dallas, Texas.

Repairs should be made with the unit disconnected from the power source. Should repair or adjustment of energized equipment be required, under no circumstance should the work be done alone. Additional personnel should be present to render aid if required.

NOTE: MAKE SURE ALL CONNECTIONS ARE MADE PROPERLY TO AVOID ACCIDENTAL OPENING OF THE CURRENT TRANSFORMER SECONDARY WHICH CAN LEAD TO DAMAGE OF THE TRANSFORMER UNDER TEST.

PRINCIPLES OF OPERATION

GENERAL DESCRIPTION

Multi-Amp Model CTER-91 is lightweight, portable unit for performing excitation, ratio and polarity tests on current transformers using the voltage comparison method. Utilizing the latest technology, Model CTER-91 provides a variable voltage output and precision instrumentation for testing single and multi-ratio CTs. All three tests, excitation, ratio and polarity, can be performed without changing any leads. Current transformers may be tested in their equipment configuration, such as being mounted in transformers, oil circuit breakers or switch gear. This eliminates the need to remove bushings or remove CTs from switchgear. Of course, it is necessary for the equipment to be totally isolated from the electrical system prior to testing.

DESCRIPTION OF CONTROLS

Power ON/OFF Switch	Energizes the test set.
MAIN OUTPUT	ControlA variable autotransformer with four ranges, 0-40 volts, 0-150 volts, 0-600 volts and 0-1000 volts which provides continuous control of the output voltage. The variable transformer must be at zero before the unit can be initiated.
FINE OUTPUT Control	A vernier for finer control of the output voltage. This vernier controls 10% of the MAIN OUTPUT value. The vernier control is connected to subtract from main output.
RUN/HOLD Switch	In HOLD mode, the test set will freeze the latest readings on the AC Ammeter, AC Secondary Voltmeter, and AC Primary Voltmeter. In RUN mode, the meters will provide continuous update.
VOLTAGE RANGE Switch	Selects either OFF, 0-40 volt, 0-150 volt,0-600 volt or 0-1000 volt range.
TEST SELECTOR Switch	Selects the desired test to be performed.
CB-2	A 12 ampere "Push to Reset" breaker which protects the main output transformer.

PRIMARY/EXTERNAL VOLTS Voltmeter	Measures the voltage on the primary of CT under test. If EXT VOLTS function is selected, it reads voltage present at EXT VOLTS binding posts.
SECONDARY VOLTS Voltmeter	Measures voltage in the output circuit that is connected to the secondary of the CT under test.
Ammeter	Measures current in the output circuit.
EXT AMPS Binding Posts	Provides a means of connecting an external ammeter in the circuit. It is not to be used to measure an external ac circuit. Note: Leave sliding short in place except when using external series ammeter.
EXT VOLTS Binding Posts	Enables the primary voltmeter to read an external ac voltage of 0-1000 volts when the selector switch is in the external voltmeter position.
GND - Ground Binding Post	In addition to an input source ground an external ground terminal is provided to ensure that the test set chasis is grounded.
X1, X2, H1, H2 Binding Posts	Connects the CT under test to the test set.

SERVICING

This test set utilizes straightforward circuits and components which require little or no service except for routine cleaning, tightening of connections, etc. The following maintenance is recommended:

1. Open the unit every six months and examine for:
   a. dirt
   b. loose connections
2. Remove dirt with dry, compressed air or a vacuum cleaner.
3. Tighten all connections, especially on the larger current wires.

DESCRIPTION OF TESTS

Ratio Test

The ratio is defined as the number of turns in the secondary as compared to the number of turns in the primary.

Apply one volt per turn to the secondary of the CT under test. Raise voltage slowly while observing meters. When one volt per turn has been reached on the secondary voltmeter, one volt should appear on the primary meter. If the CT saturates before one volt per turn is reached, apply a smaller voltage which is a convenient fraction of one volt per turn. (e.g. .5v per turn). The Primary voltmeter should read the chosen fraction of a volt. If a multi-ratio CT is being tested, the selector switch can be placed in the "External Meter" position. The primary voltmeter can be used to read the voltage between taps on the secondary winding while a known voltage per turn is applied to the winding, either between taps or to the full winding.

CAUTION: TO PROTECT AGAINST INSULATION FAILURE, DO NO EXCEED MORE THAN 1000 VOLTS ON ANY OF THE SECONDARY WINDINGS OF THE CT UNDER TEST.

Leads should be connected to the test set EXT VOLTS binding posts only when the selector switch is in the EXT METER CONNECTION position.

Polarity Test

Indicates the designation of the relative instantaneous directions of the currents entering the primary terminals and leaving the secondary terminals during most of each $^1/_2$ cycle.

Switch the rotary switch to the "SEC ÷ 10 + PRI" position. Raise the secondary voltage to a known voltage per turn or to a percent of volts per turn that will not saturate the CT. Voltage displayed on the primary meter should be secondary voltage divided by 10 plus the primary voltage. Switch the rotary switch to "SEC ÷ 10 - PRI" position voltage displayed on the primary meter should be secondary voltage divided by 10 minus primary voltage.

Example: With a CT with a ratio of 120:1, 600:5 current ratio, and one half the voltage applied voltage or 60 volts, the polarity is correct if the primary meter reads 6.5, which is 60 divided by 10 plus the voltage from the primary meter. Switch the TEST SELECTOR Switch to "SEC ÷ 10 - PRI" and the reading should be 5.5 The divide by 100 positions may be used in the same manner.

SEC ÷ 100 + Primary = (.6 + .5) = 1.1 volts
SEC ÷ 100 - Primary = (.6 - .5) = .1 volts

Saturation Test

IEEE defines saturation as "the point where the tangent is at 45° to the secondary exciting amperes." (See Figures 7 and 8).

With the test set secondary binding posts X1 and X2 connected to the CT secondary and the H1 and H2 binding posts connected to the CT primary, increase output observing the ammeter and secondary voltmeter. Increase voltage until a small increase in voltage causes a large increase in current. Most CT's will saturate at 1 amp or less and 600 volts or less.

Note: It may be necessary to plot a curve to detect the saturation point. See Figures 7, 8 and ANSI/IEEE C57.13 for illustrations of typical curves for Class C transformers.

Test Preparation Notes

Notes on the Theory of Current Transformer Ratio and Polarity Testing Using Secondary Voltage Injection.

1. Carefully observe the polarity when connecting the CT.

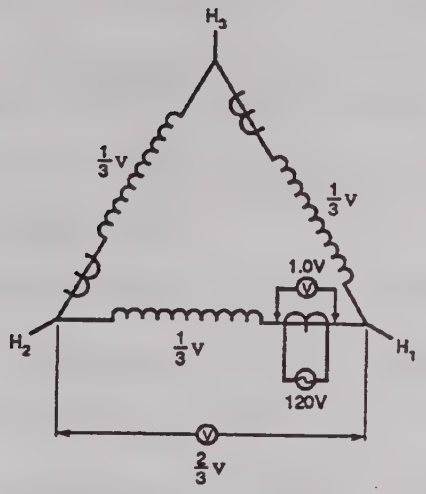
2. Be careful not to saturate current transformer during ratio or polarity tests or results will be in error.

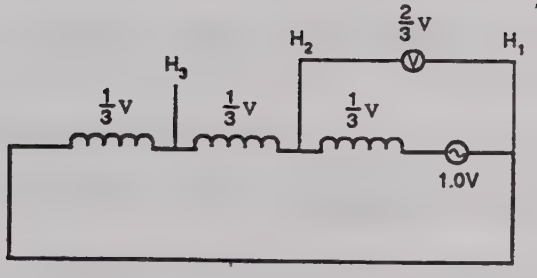
3. Apply no more than rated voltage, as indicated by the turns ratio, to the secondary taps being tested.

   Example: A 600:5 CT implies a 120:1 turns ratio. Therefore, 120 volts impressed on the entire CT secondary winding should produce 1.0 volt reading, H1-H2 terminals, on the primary voltmeter. If saturation occurs, reduce the impressed voltage to 60 volts which should read 0.5 volts on the primary meter.

4. The test leads connecting the meters to the H1-H2-H3 terminals of the device under test are shielded and the shields nearest the meters are tied together and grounded.

5. When testing CT ratios, where CT's are connected INSIDE the delta winding connection, only 2/3 voltage will be measured on the phase to phase primary. This is a result of the voltage dividing network created by the connection. (See drawings).


H3
1/3 V
1/3 V
1.0V
H2
1/3 V
H1
120V
2/3 V


2/3 V
H2
H1
H3
1/3 V
1/3 V
1/3 V
1.0V

OPERATING INSTRUCTIONS

Set-up controls before testing

Control	Position
Power ON/OFF	OFF
Output Controls	Zero (counterclockwise)
TEST SELECTOR Switch	Saturate and ratio test
TEST VOLTAGE Switch	As required
RUN/HOLD	Run
Range Switch	As required

CAUTION: FOR OPERATOR AND EQUIPMENT SAFETY, MAKE SURE CURRENT TRANSFORMERS ARE DE-ENERGIZED BEFORE ANY TESTING IS STARTED.

Ratio Test

1. Refer to the appropriate Figure in the Appendix for test connections.

2. Verify that the Power ON/OFF switch is OFF. Connect the test set to a suitable source of power (as indicated on the nameplate) and ground.

3. Connect the test set secondary output binding posts X1 and X2 to secondary of current transformer X1 and X2. Observe polarity marks on the CT (X1 on the CTER-91 is polarity).

4. Connect the test set primary binding posts H1 and H2 to CT primary bushings H1 and H2. Observe polarity marks (H1 on the CTER-91 is polarity).

5. Turn Power ON/OFF switch to ON.

6. Slowly increase MAIN OUTPUT control to apply approximately 100% - 105% output voltage to the transformer under test. Use FINE CONTROL to adjust to 100% output voltage.

   Example: A 300:5 transformer implies a turns ratio of 60:1. Therefore, 60 volts impressed on the entire secondary should produce 1.0 volts on the primary voltmeter. If saturation occurs reduce impressed voltage to 30 volts, which will produce 0.5 volts on the primary. (In some cases, a further reduction of the

impressed voltage might be required to keep the CT from saturation. The procedure remains the same, regardless of the impressed voltage value).

7. When the expected value is read on the secondary voltmeter, a voltage will appear on the primary voltmeter. Switch the RUN/HOLD switch to HOLD.

8. Slowly decrease OUTPUT control to zero and record data.

9. Return RUN/HOLD switch to RUN.

Polarity Test

1. Move TEST SELECTOR Switch to "SEC ÷ 10 + PRI" position.

2. Refer to the appropriate Figure in the Appendix for test connections.

3. Verify that the Power ON/OFF switch is OFF. Connect the test set to a suitable source of power (as indicated on the nameplate) and ground.

4. Connect the test set secondary output binding posts X1 and X2 to secondary of current transformer X1 and X2. Observe polarity marks on the CT (X1 on the CTER-91 is polarity).

5. Connect the test set primary binding posts H1 and H2 to CT primary bushings H1 and H2. Observe polarity marks (H1 on the CTER-91 is polarity).

6. Turn Power ON/OFF switch to ON.

7. Slowly increase OUTPUT control to a known voltage.

8. Switch the RUN/HOLD Switch to HOLD. Return OUTPUT control to zero. Read and record the values.

9. Return RUN/HOLD Switch to RUN.

Polarity is correct if the primary voltmeter indicates the secondary voltage being applied divided by ten plus voltage feeding back from the primary. For example, using a 200:1 transformer excited to 200 volts, the primary voltmeter would read 21 volts.

Note 1:

When working with transformers where the meter indication only changes by a small fraction, it is suggested that the user also perform a polarity test with "SEC ÷ 10 - PRI" (using the method described above). This will give the user a second opportunity to validate the polarity.

Polarity is correct if the primary voltmeter indicates the secondary voltage being applied divided by ten minus voltage feeding back from the primary. For example, using a 200:1 transformer excited to 200 volts, the primary voltmeter would read 19 volts.

Note 2:

For larger transformers, the "SEC ÷ 100 ± PRI" would be more applicable. The procedure would remain the same except substitute "SEC ÷ 100 ± PRI" where appropriate.

Saturation Test

1. Refer to appropriate Figure in the Appendix for test connections.

2. Verify that the Power ON/OFF switch is OFF. Connect the test set to a suitable source of power (as indicated on the nameplate) and ground.

3. Connect the test set secondary output binding posts X1 and X2 to secondary of current transformer X1 and X2. Observe polarity marks on the CT (X1 on the CTER-91 is polarity).

4. Connect the test set primary binding posts H1 and H2 to CT primary bushings H1 and H2. Observe polarity marks (H1 on the CTER-91 is polarity).

5. Turn Power ON/OFF switch to ON.

6. Slowly increase OUTPUT control observing ammeter and secondary voltmeter. When a very small increase in voltage causes a large increase in current, the CT has reached the saturation point (Usually less than one amp).

7. Switch the RUN/HOLD to HOLD position. Return output control to zero. Read and record the saturation amperes and voltage.

8. Return RUN/HOLD switch to RUN.

Service and Repair Order Instructions

If factory service is required or desired, contact the factory for return instructions.

A Repair Authorization (RA) number will be assigned for proper handling of the unit when it arrives at the factory.

If desired, a letter with the number and instructions can be provided.

Provide the factory with model number, serial number, nature of the problem or service desired, return address, your name, and where you can be reached should the factory need to contact you.

A purchase order number, cost limit, billing, and return shipping instructions may also be provided if desired.

If an estimate is requested, provide the name and contact information of the person with approval/disapproval authority.

Pack the equipment appropriately to prevent damage during shipment. If a reusable crate or container is used, the unit will be returned in it if in suitable condition.

Put the RA number on the address label of the shipping container for proper identification and faster handling.

NOTE: Ship the equipment **without** instruction manuals or non-essential items such as test leads, spare fuses, etc. These items are not needed to conduct repairs.

Warranty Statement

Multi-Amp Corporation warrants to the original purchaser that the product is free from defects in material and workmanship for a period of one (1) year from date of shipment. This warranty is limited and shall not apply to equipment which has damage, or cause of defect, due to accident, negligence, improper operation, faulty installation by purchaser, or improper service or repair by any person, company or corporation not authorized by the Multi-Amp Corporation.

Multi-Amp Corporation will, at its' option, either repair or replace those parts and/or materials that it deems to be defective. Any costs incurred by the purchaser for the repair or replacement of such parts and/or materials shall be the sole responsibility of the original purchaser.

THE ABOVE WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED ON THE PART OF THE MULTI-AMP CORPORATION, AND IN NO EVENT SHALL THE MULTI-AMP CORPORATION BE LIABLE FOR THE CONSEQUENTIAL DAMAGES DUE TO THE BREACH THEREOF.

APPENDIX

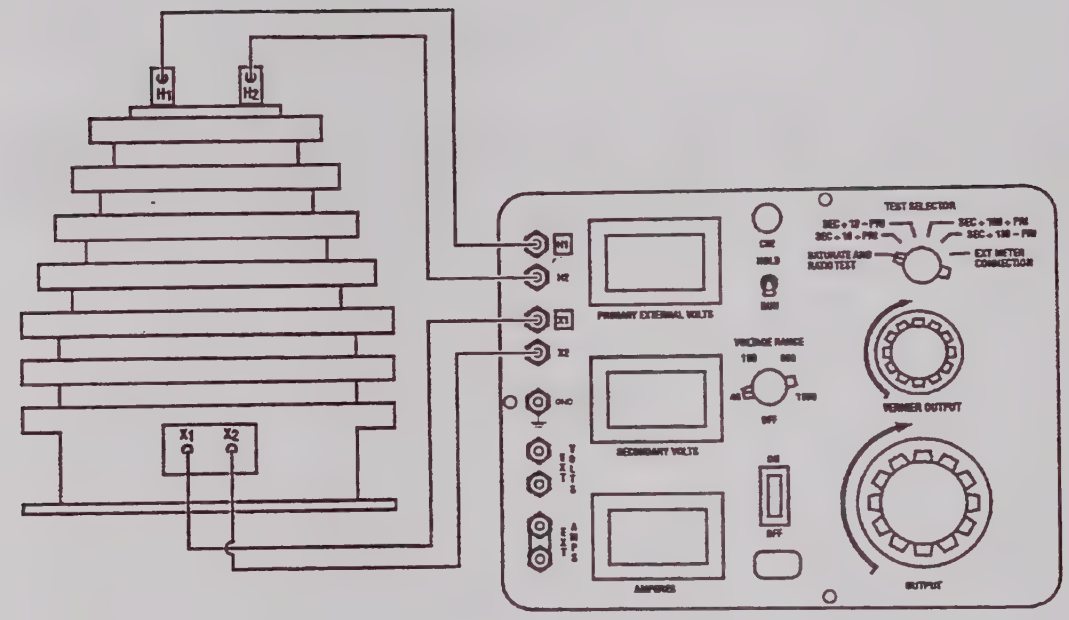


FIGURE 1
SATURATE AND RATIO TEST

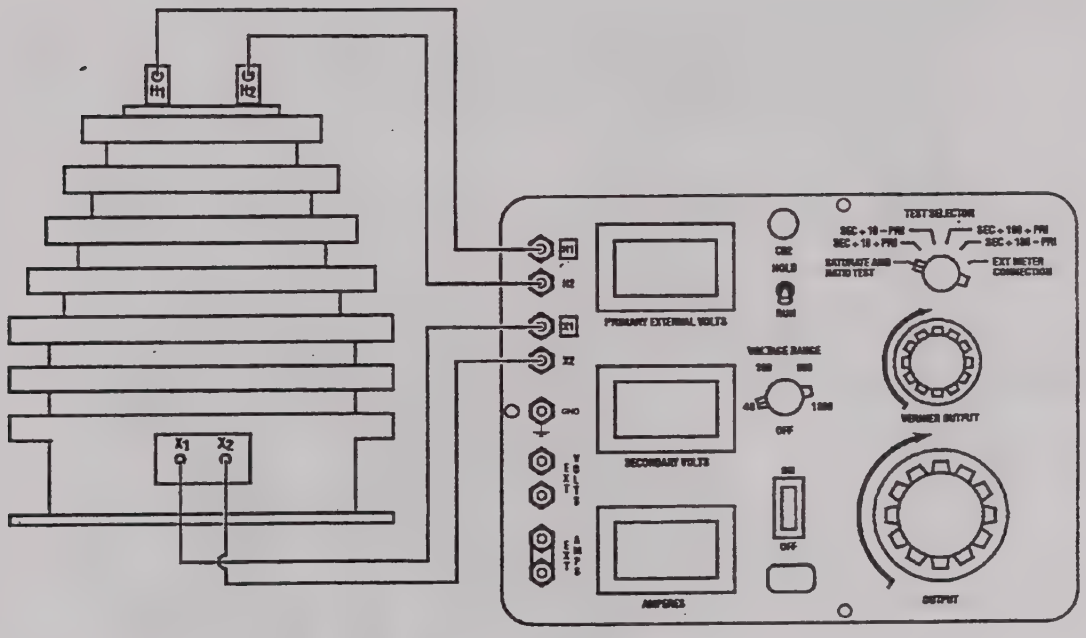


FIGURE 2
POLARITY TEST

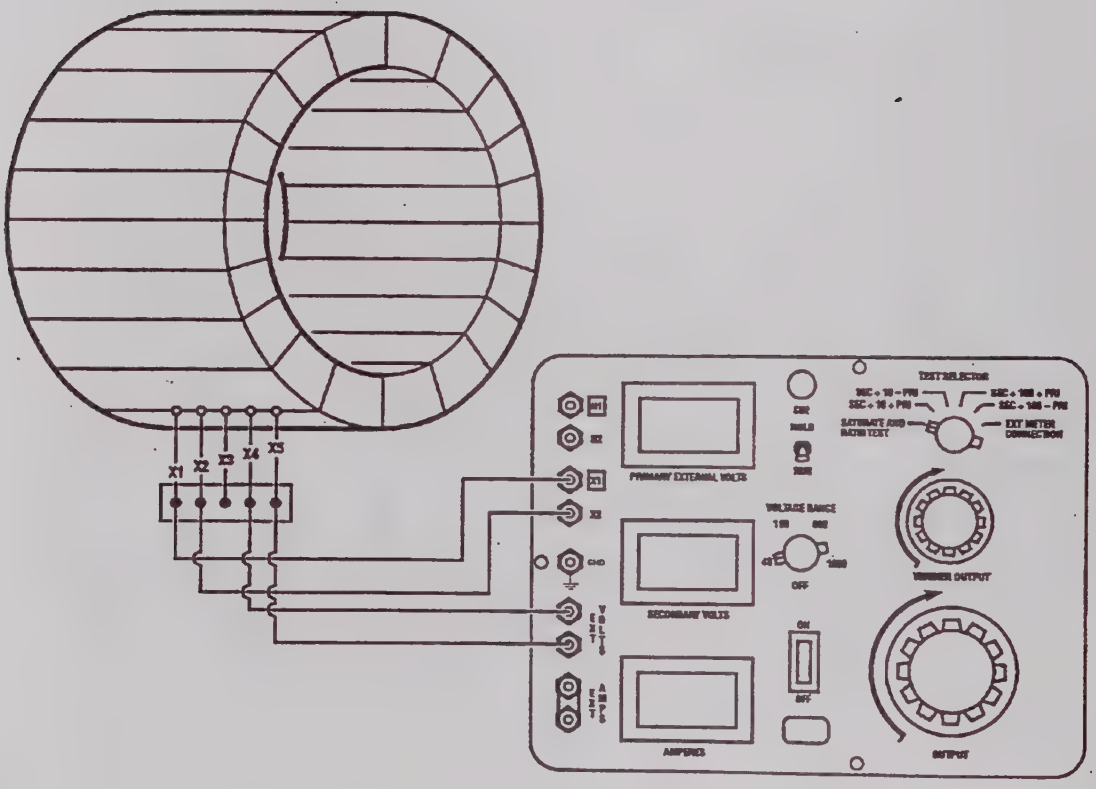


FIGURE 3
MULTI-RATIO CURRENT TRANSFORMER TEST

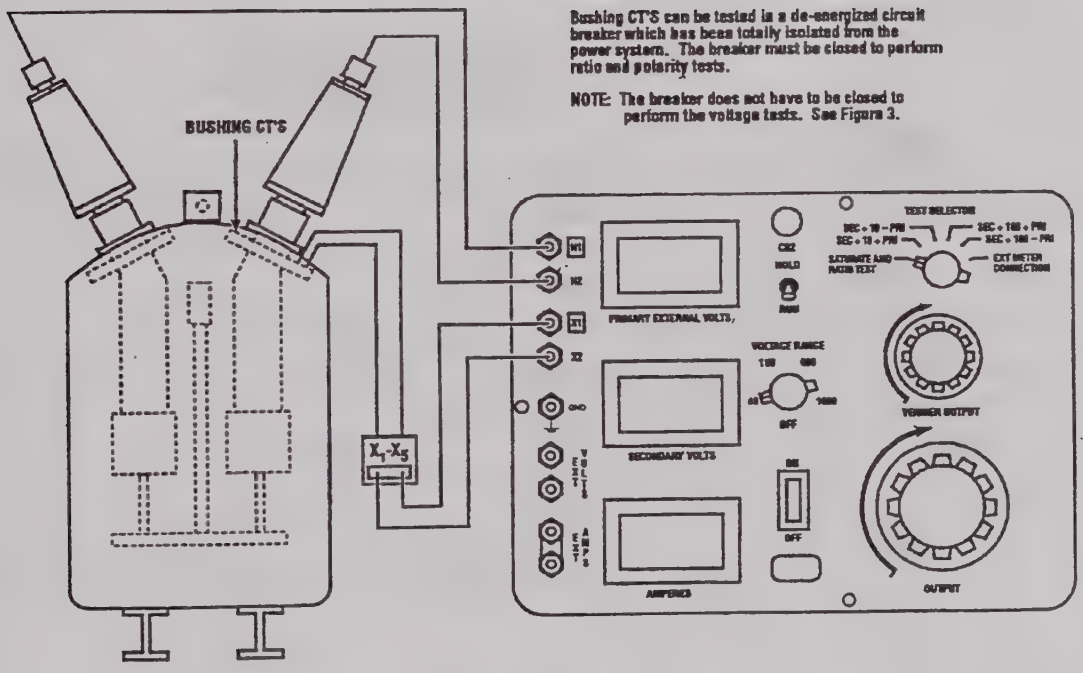

BUSHING CT'S
Bushing CT'S can be tested in a de-energized circuit breaker which has been totally isolated from the power system. The breaker must be closed to perform ratio and polarity tests.
NOTE: The breaker does not have to be closed to perform the voltage tests. See Figure 3.
X_1-X_5
H1
H2
X1
X2
PRIMARY EXTERNAL VOLTS
SECONDARY VOLTS
AMPERES
TEST SELECTOR
VERNIER OUTPUT
OUTPUT
OFF

FIGURE 4
TESTING BUSHING CURRENT TRANSFORMER
INSTALLED IN A CIRCUIT BREAKER

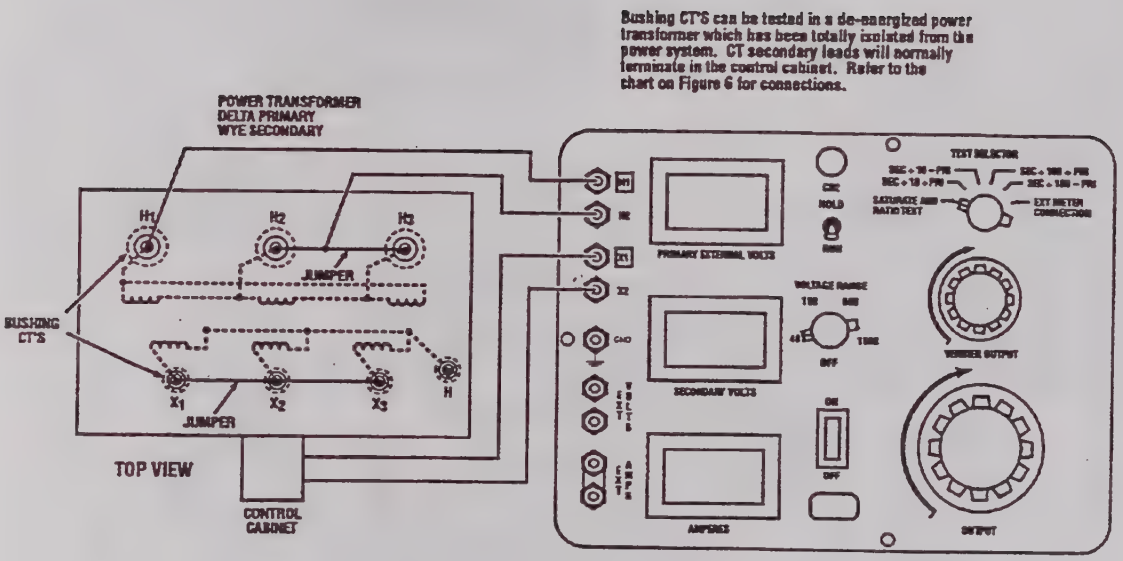


FIGURE 5
TESTING BUSHING CURRENT TRANSFORMER
INSTALLED IN A POWER TRANSFORMER

CT Locations	Tests Set Connections X1 X2	H1	H2	Jumpers
H1 Bushing	Secondary of H1 CT located in control cabinet	H1 Bushing	H2 Bushing	H2 - H1 X1 - X2 - X3
H2 Bushing	Secondary of H2 CT located in control cabinet	H2 Bushing	H3 Bushing	H3 - H1 X1 - X2 - X3
H3 Bushing	Secondary of H3 CT located in control cabinet	H3 Bushing	H1 Bushing	H1 - H2 X1 - X2 - X3
X1 Bushing	Secondary of X1 CT located in control cabinet	X1 Busing	Neutral Bushing	H1 - H2 - H3
X2 Bushing	Secondary of X2 CT located in control cabinet	X2 Bushing	Neutral Bushing	H1 - H2 - H3
X3 Bushing	Secondary of X3 CT located in control cabinet	X3 Bushing	Neutral Bushing	H1 - H2 - H3

FIGURE 6-TEST SET CONNECTIONS

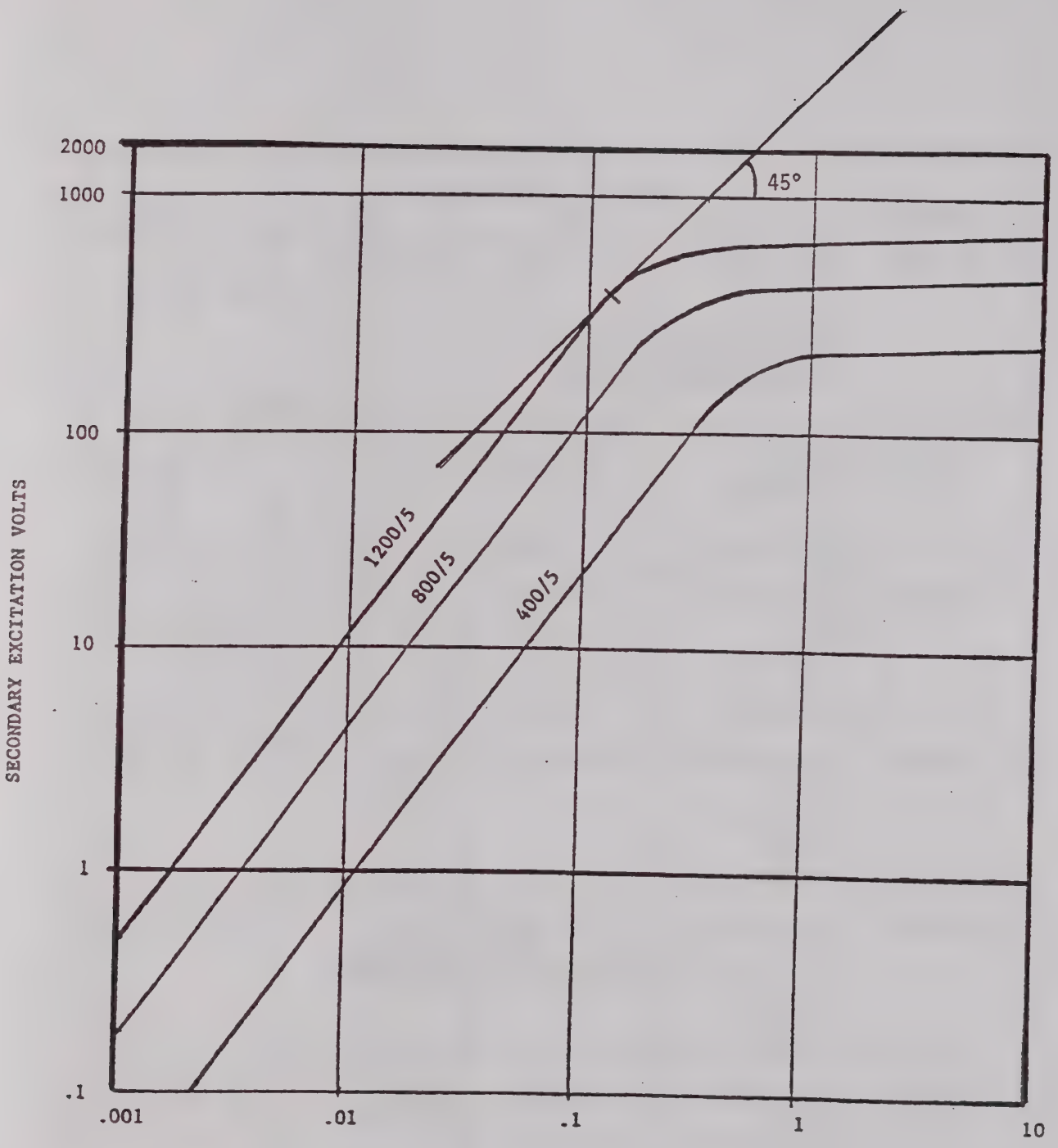
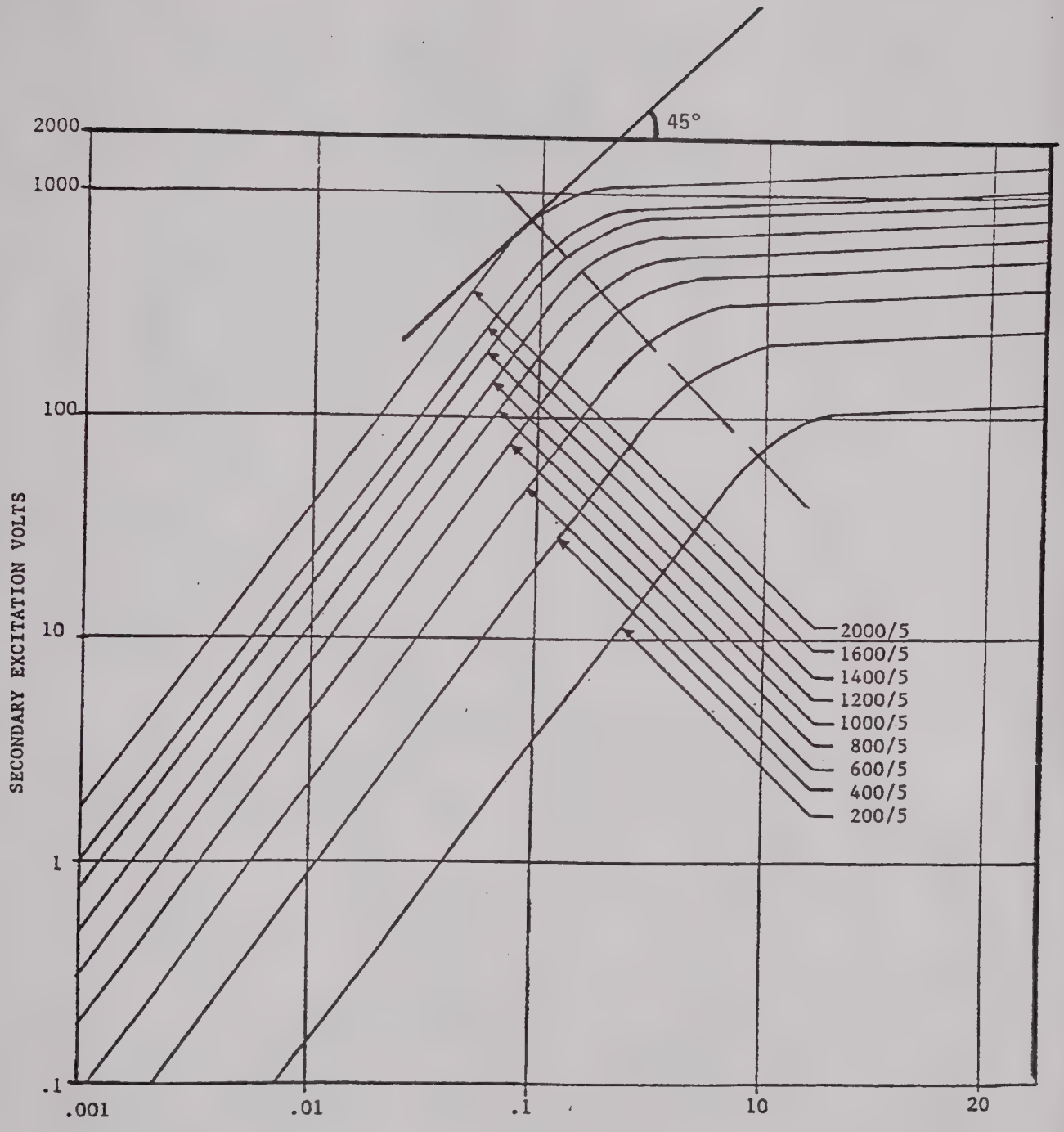
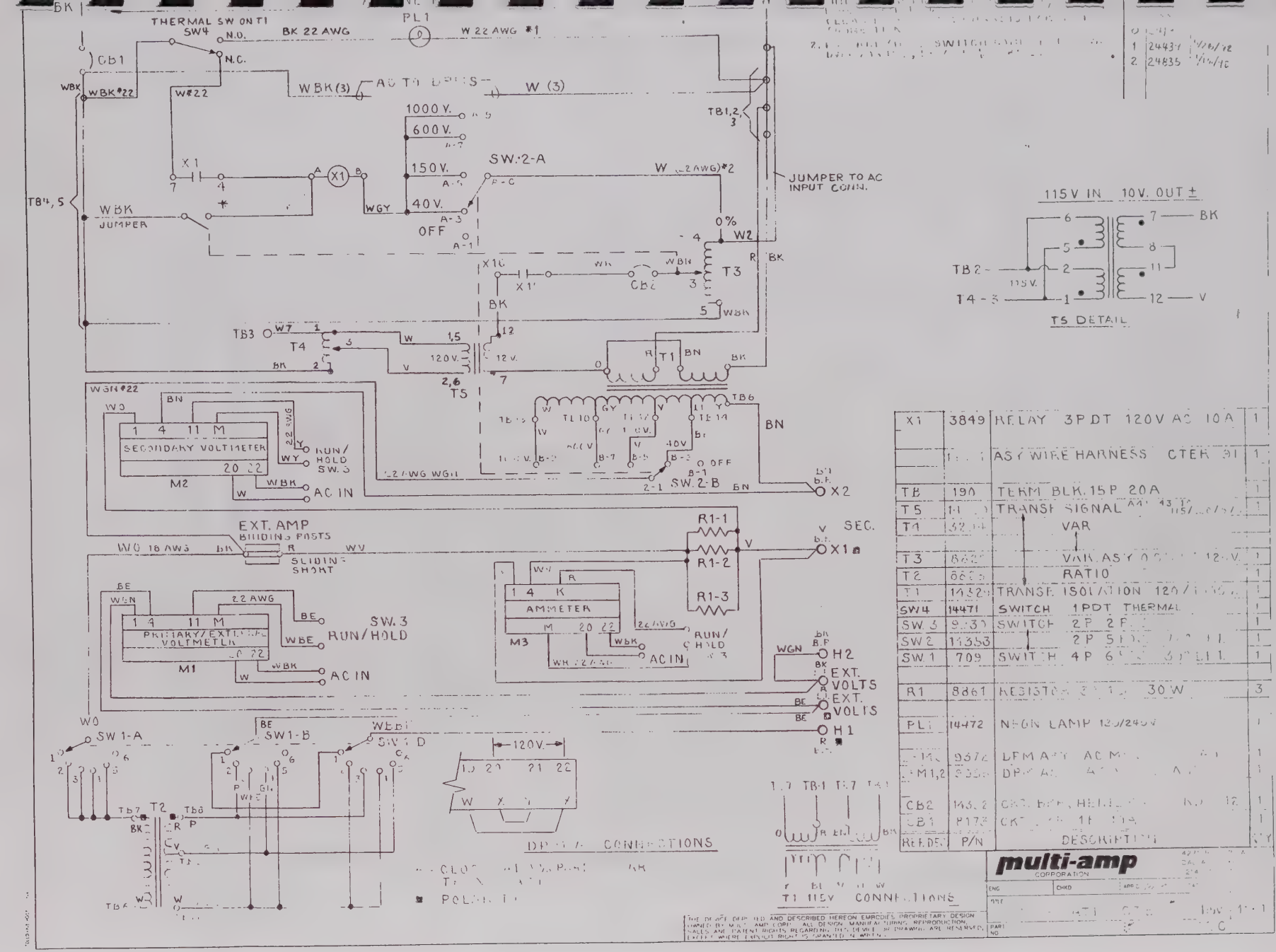


FIGURE 7-SATURATION CURVES



SECONDARY EXCITING AMPERES
MAXIMUM RATIO - 2000/5 ASA ACCURACY - 10L800
FIGURE 8-SATURATION CURVES



REV	DESCRIPTION	DATE
1	24431	1/26/72
2	24835	1/14/72

REF.DES	P/N	DESCRIPTION	QTY
X1	3849	RELAY 3PDT 120V AC 10A	1
		ASY WIRE HARNESS CTER 31	1
TB	190	TERM BLK.15P 20A	1
T5		TRANSF SIGNAL	1
T4		VAR	
T3		VAR ASY	1
T2		RATIO	1
T1		TRANSF ISOLATION 120/	1
SW4	14471	SWITCH 1PDT THERMAL	1
SW.3		SWITCH 2P 2P	1
SW2	11353	2P 5P	1
SW.1	709	SWITCH 4P 6	1
R1	8861	RESISTOR 30W	3
PL1	14472	NEON LAMP 120/240V	1
CB1	9372	THERMAL AC	1
TB1,2		DP	1
CB2		CKT BKR	1
CB1		CKT	1

multi-amp CORPORATION

ENG | CHKD | APP

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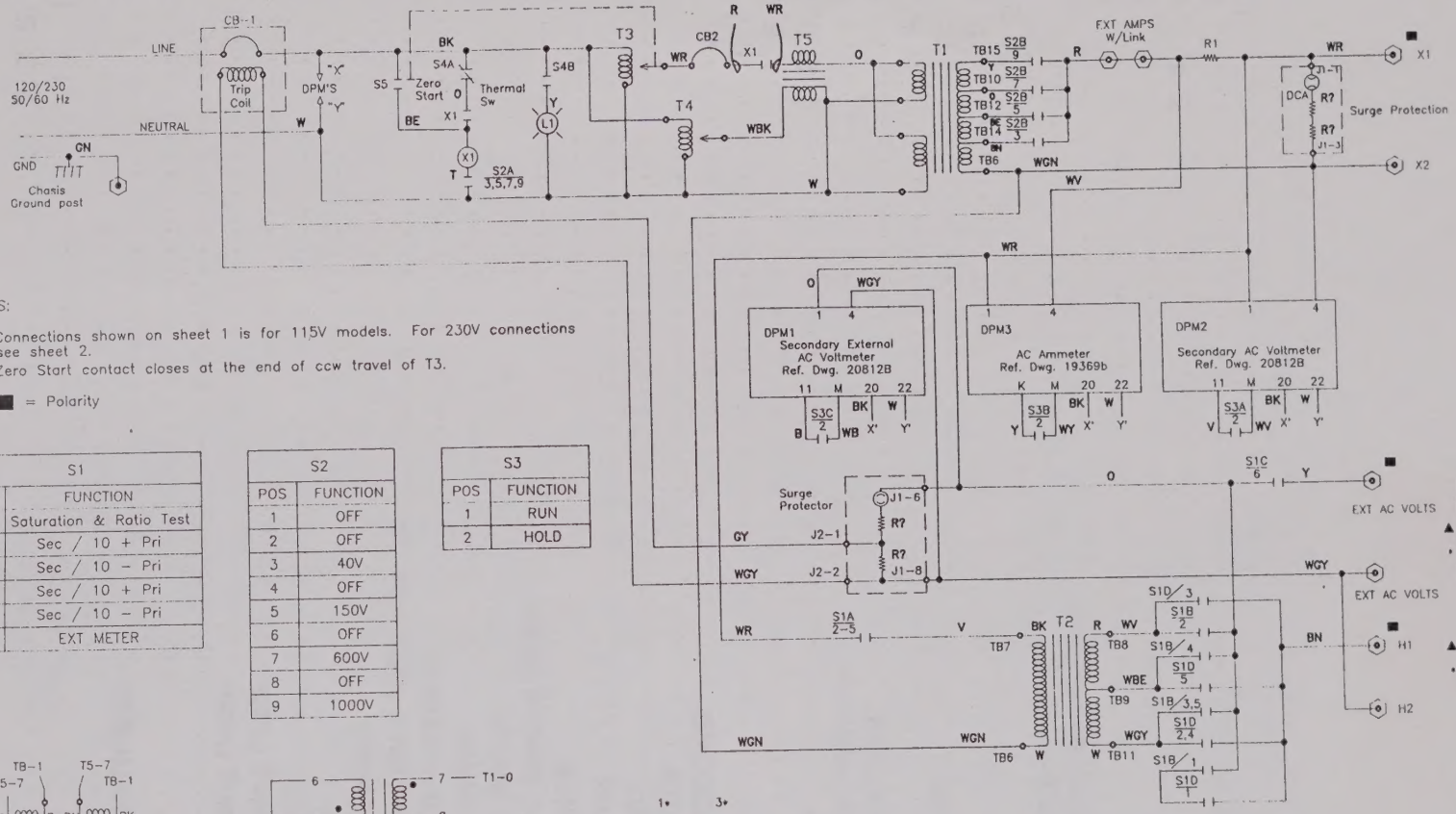
PART NO | REV C

REV	ECN	
J	25893	SEE ECN



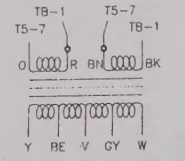
NOTES:

1. Connections shown on sheet 1 is for 115V models. For 230V connections see sheet 2.
2. Zero Start contact closes at the end of ccw travel of T3.
3. ■ = Polarity

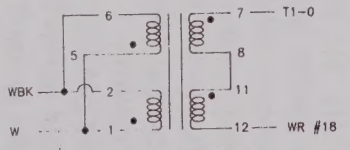
S1	
POS	FUNCTION
1	Saturation & Ratio Test
2	Sec / 10 + Pri
3	Sec / 10 – Pri
4	Sec / 10 + Pri
5	Sec / 10 – Pri
6	EXT METER

S2	
POS	FUNCTION
1	OFF
2	OFF
3	40V
4	OFF
5	150V
6	OFF
7	600V
8	OFF
9	1000V

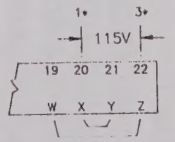
S3	
POS	FUNCTION
1	RUN
2	HOLD



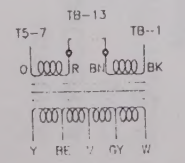
T1 115V CONNECTIONS



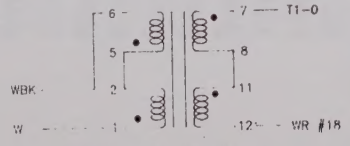
T5 115V CONNECTIONS



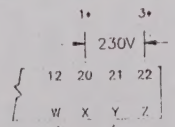
115V DPM AC CONNECTIONS (TYP)



T1 230V CONNECTIONS



T5 230V CONNECTIONS



230V DPM AC CONNECTIONS (TYP)

REPLACEMENT PARTS LIST
115V PARTS •
230V PARTS ▲

X1	16015	RELAY
X1	3849	RELAY
PCA	15648	PCA S
T5	14330	TRANSF
T4	3294	TRA
T3	9891	TRANSF. VA
T3	8829	TRANSF. VA
T2	8828	
T1	14329	TRANSF.
S4	14471	SWITC
S3	9930	SW
S2	14353	SWITCH
S1	709	SWITCH
S5	9930	ZERO
R1	8861	RES
L1	14472	NEO
DPM3	9372	DPM ASY
DPM1,2	9056	DPM A
CB2	14352	
CB1	15903	CKT.
REF DES	P/N	

THIRD ANGLE PROJECTION

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UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS IN INCHES & INCLUDE APPLIED FINISH.
TOLERANCE 2 PL ± .030
3 PL ± .010
ANGLES ± 1°
REMOVE BURRS AND BREAK SHARP EDGES .63
ALL SURFACES
MATERIAL

SIGNATURES	DATE
DWN M BAUGUS	2MAR94
CHK	
ENGR	
APVD	
RELEASE	
FILE NO	28301A03
PART NO	CIRC 91

TITLE CIR

SIZE D | DWG NO

SCALE NTS

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